INVESTIGATING THE LOCAL FATIGUE PROPERTIES OF MATERIALS BY DYNAMIC MICROPILLAR COMPRESSION

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Dynamic nanoindentation, also referred to as continuous stiffness measurements (CSM), is widely used for pyramidal and spherical indentation. It is shown here that this robust method and its associated hardware can also be used to probe the local fatigue properties of materials up to the high cycle fatigue regime. Here, the CSM technique allows cyclically loading FIB-fabricated micropillars with a flat punch for up to 10^6 times. The stress amplitude is kept constant throughout testing. The resulting strain amplitude is recorded and serves as a basis for the construction of a Wöhler diagram. It is further shown that the plastic amplitude can be calculated from the phase angle measured by the lock-in amplifier during testing. Applications to ECAP (Equal Channel Angular Pressing) copper samples will be presented. Generally, the method has a great potential for studying the local cyclic behavior of individual layers of complex systems and would also be of great advantage for studying local fatigue effects at interfaces.

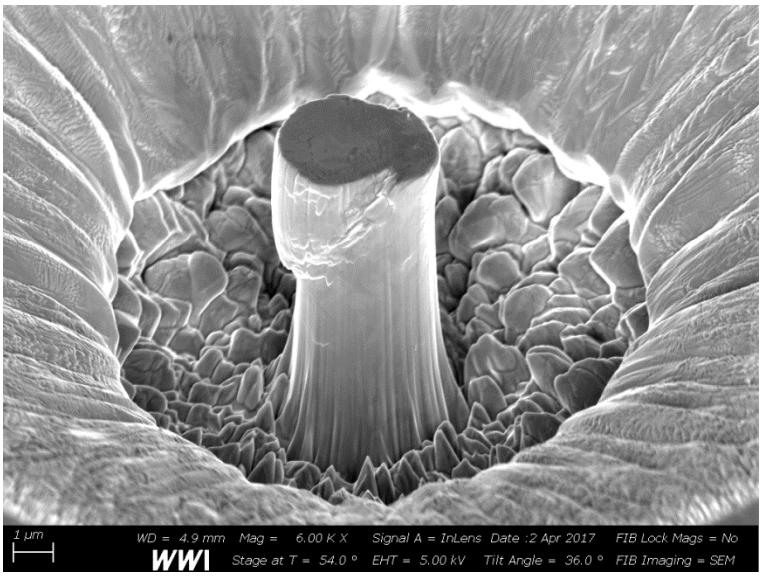

Figure: ECAP Cu micropillar after 10^6 cycles